

New Hampshire Volunteer Lake Assessment Program

2002 Interim Report for Partridge Lake Littleton



NHDES
Water Division
Watershed Management Bureau
6 Hazen Drive
Concord, NH 03301



OBSERVATIONS & RECOMMENDATIONS

We would like to encourage your monitoring group to conduct more sampling events in the future. Typically we recommend that each monitoring group sample at least three times per summer (once in June, July, and August). We understand that the number of sampling events you decide to conduct per summer will depend upon volunteer availability and your associations' water monitoring goals and funding availability. However, with a limited amount of data it is difficult to determine accurate and representative lake quality trends. Since weather patterns and activity in the watershed can change throughout the summer, and from year to year (and even from hour to hour during a rain event), it is a good idea to sample more than once or twice over the course of the season. If you are having difficulty finding volunteers to help sample, or to pick-up or drop-off equipment at one of the labs, please give the VLAP Coordinator a call and we will try to help you work out an arrangement.

After reviewing data collected from **PARTRIDGE LAKE**, the program coordinators recommend the following actions.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake has been monitored through the program.

Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a and are naturally found in lake ecosystems, the chlorophyll-a concentration found in the water gives an estimation of the concentration of algae or lake productivity. The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.

Similar to the summer of 2001, the summer of 2002 was filled with many warm and sunny days and there was a lower than normal amount of rainfall during the latter-half of the summer. The combination of these factors resulted in relatively warm surface waters throughout the state. The lack of fresh water to the lakes/ponds reduced the rate of flushing which may have resulted in water stagnation. Due to these conditions, many lakes and ponds experienced increased algae growth, including filamentous green algae (the billowy clouds of green algae typically seen floating near shore), and some lakes/ponds experienced nuisance cyanobacteria (blue-green algae) blooms.

The chlorophyll-a concentration **decreased greatly** from the July to August sampling event. In July, the concentration was **much greater** than the state mean, but in August the concentration was **slightly less** than the state mean.

The historical data (the bottom graph) shows that the 2002 chlorophyll-a mean is **greater than** the state mean. It is important to point out that the mean annual chlorophyll-a concentration this summer is the **highest** annual mean since monitoring began. This is due to the **elevated** concentration in July.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **variable** in-lake chlorophyll-a trend, meaning that the concentration has **fluctuated** since monitoring began in 1989.

For the 2003 annual report, since there will have been at least 10 consecutive years of sample collection for the lake, we will conduct a statistical analysis of the data. This will allow us to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Therefore, algal concentrations may increase when there is an increase in nonpoint sources of nutrient loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). It is important to continually educate residents about how activities within the watershed can affect phosphorus loading and lake quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.

Two different weather related patterns occurred this past spring and summer that influenced lake quality during the summer season.

In late May and early June of 2002, numerous rainstorms occurred. Stormwater runoff associated with these rainstorms may have increased phosphorus loading, and the amount of soil particles washed into waterbodies throughout the state. Some lakes and ponds experienced lower than typical transparency readings during late May and early June.

However, similar to the 2001 sampling season, the lower than average amount of rainfall and the warmer temperatures during the latter-half of the summer resulted in a few lakes/ponds reporting their best-ever Secchi-disk readings in July and August (a time when we often observe reduced clarity due to increased algal growth)!

The transparency **increased** by approximately 1.5 meters from the July to August sampling event this season. It is interesting to note that as the chlorophyll-a concentration **decreased** from July to August this season, the transparency **increased**. We typically expect this inverse relationship in lakes. As the concentration of algal cells in the water column decreases, the transparency increases.

The historical data (the bottom graph) shows that the 2002 mean transparency is **greater than** the state mean. Overall, visual inspection of the historical data trend line (the bottom graph) shows a **variable** trend for in-lake transparency, meaning that the transparency has **fluctuated** since monitoring began.

Again, for the 2003 annual report, since there will have been at least 10 consecutive years of sample collection for the lake, we will conduct a statistical analysis of the data. This will allow us to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into the lake/pond and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond.

Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants are available from NHDES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.

The historical data for the epilimnion (upper layer) show that the 2002 total phosphorus mean is **approximately equal to** the state median. Overall, visual inspection of the historical data trend line for the epilimnion shows **a relatively stable** total phosphorus trend, which means that the concentration has **remained approximately the same (and slightly less than the state median)** in the epilimnion since monitoring began.

The historical data for the hypolimnion (lower layer) show that the 2002 total phosphorus mean is **much greater than** the state median. Overall, the historical data trend line for the hypolimnion shows a **fluctuating, but overall increasing**, total phosphorus trend, which means that the concentration has **worsened** in the hypolimnion since monitoring began in 1989. However, it is worthy to note that within the hypolimnion the total phosphorus mean has significantly decreased in the past two years. We hope that this trend will continue to occur.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands. If you would like to educate watershed residents about how they can help to reduce phosphorus loading into the lake/pond, please contact the VLAP Coordinator.

TABLE INTERPRETATION**➤ Table 2: Phytoplankton**

Aphanizomenon, a cyanobacterium, was one of the most dominant species observed in the plankton sample this season (as it has been in previous seasons). In addition, small amounts of the cyanobacterium ***Microcystis*, *Anabaena*, and *Oscillatoria*** were also observed. ***If present in large amounts, these species can be toxic to livestock, wildlife, pets, and humans*** (Refer to page 14 of the “Biological Monitoring Parameters” section of this report for a more detailed explanation). Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur.

As with the summer of 2001, we observed that some lakes and ponds had cyanobacteria present during the 2002 summer season, likely due to the many warm and sunny days that occurred this summer, which may have accelerated algal and bacterial growth. In addition, the lower than normal amount of rainfall during the latter half of the summer, meant that the slow flushing rates resulted in less phosphorus exiting the lake outlet and more phosphorus being available for plankton growth.

The presence of cyanobacteria serves as a reminder of the lake’s delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake by eliminating fertilizer use on lawns, keeping the lake shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake in September and October during the time of fall turnover (lake mixing) to document any blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to “pile” cyanobacteria into “surface scums” that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

➤ Table 4: pH

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire’s

lakes and ponds is 6.5, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to page 16 of the “Chemical Monitoring Parameters” section of this report.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

➤ **Table 5: Acid Neutralizing Capacity**

Table 5 in Appendix B presents the current year and historic epilimnetic ANC for each year the lake has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. For a more detailed explanation, please refer to page 16 of the “Chemical Monitoring Parameters” section of this report.

➤ **Table 6: Conductivity**

Table 6 in Appendix B presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. For a more detailed explanation, please refer to page 16 of the “Chemical Monitoring Parameters” section of this report.

➤ **Table 8: Total Phosphorus**

Table 8 in Appendix B presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae’s ability to grow and reproduce. Please refer to page 17 of the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

➤ **Table 9 and 10: Dissolved Oxygen and Temperature Profile Data**

Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) for the 2002 sampling season. Table 10 shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

The dissolved oxygen concentration was **greater than** 100% saturation at **4.0, 5.0, and 6.0** meters at the deep spot on the **August 22nd** sampling event. Layers of algae can raise the dissolved

oxygen in the water column, since oxygen is a by-product of photosynthesis. Considering that the depth of the photic zone (depth to which sunlight can penetrate into the water column) was approximately **4.8** meters on this date (as shown by the Secchi-disk transparency), and that the metalimnion (the layer of rapid decrease in water temperature and increase in density – a place where algae are often found) was located between approximately **5.0** and **9.0** meters, we suspect that an abundance of algae caused the oxygen super saturation. In addition, it is important to note that the elevated turbidity in the metalimnion supports the explanation that a mass of algal cells was present.

The dissolved oxygen concentration was **again low** in the hypolimnion at the deep spot of the lake. As stratified lakes/ponds age, and as the summer progresses, oxygen becomes **depleted** in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment.

In addition, during this season, and many past sampling seasons the lake has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of **internal total phosphorus loading** (commonly referred to as **internal loading**) is occurring in the lake. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as it was this season and in many past seasons), the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column.

Since an internal source of phosphorus in the lake may be present, it is even more important that watershed residents act proactively to minimize external phosphorus loading from the watershed.

The **low** oxygen level in the hypolimnion is a sign of the lake's **aging** and **declining** health. This year the DES biologist conducted the temperature/dissolved oxygen profile in **AUGUST**. We recommend that the annual biologist visit for the 2003 sampling season be scheduled during **JUNE** so that we can determine if oxygen is depleted in the hypolimnion **earlier** in the sampling season.

➤ **Table 11: Turbidity**

Table 11 in Appendix B lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is

strongly influenced by turbidity. Please refer to page 19 of the “Other Monitoring Parameters” section of this report for a more detailed explanation.

The turbidity of the hypolimnion (lower layer) sample was elevated on the both the **July 29th and August 22nd** sampling events. This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

➤ **Table 12: Bacteria (*E.coli*)**

Table 12 lists the current year data for bacteria (*E.coli*) testing. *E. coli* is a normal bacterium found in the large intestines in humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured, and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful pathogens may also be present. Please consult page 20 of the “Other Monitoring Parameters” section of the report for the current standards for *E. coli* in surface waters. If residents are concerned about sources of *E.coli* such as septic system impacts, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high or after rain events.

The *E. coli* concentration at a **Roadside Seep** was **elevated** (200 counts per 100 mL of sample) on the **July 29th** sampling event. The concentration **was not above** the state standard of 406 counts per 100 mL designated for Class B waters.

If you are concerned about *E. coli* levels at this station, your monitoring group may want to conduct stormwater sampling in this area so that we can determine what may be causing the increases. For a detailed explanation on how to conduct stormwater sampling, please refer to this year’s special topic that is found in Appendix D of this report.

➤ **Other Comments:**

The Partridge Lake Diagnostic Study reached the end of the field-sampling component in October of 2001. Data are currently being processed for the preparation of the final report. The final report should be completed by the end of 2003.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake, the biologist conducted a “Sampling Procedures Assessment Audit” for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor’s Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group performed **very well** while collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures. The biologist did identify one aspects regarding sample collection that the volunteer monitors could improve upon.

- **Anchoring at deep spot:** Please remember to use an anchor with sufficient weight and sufficient amount of rope to prevent the boat from drifting while sampling at the deep spot. It is difficult for the biologist to collect an accurate and representative dissolved oxygen/temperature profile when the boat is drifting. In addition, it is difficult to view the secchi disk and collect samples from the proper depths when the boat is drifting. Depending on the depth of the lake/pond and the wind conditions, it may be necessary to use two anchors!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a **very good** job when collecting samples this season! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify a few

aspects of sample collection that the volunteer monitors could improve upon. They are as follows:

- **Secchi-disk Readings:** When measuring the transparency at the deep spot, please remember to take at least two secchi disk readings. Record these readings in meters and fill in the appropriate data on the field data sheet. Since the depth to which the secchi disk can be seen in the water can vary depending on how windy or sunny it is, and also on the eyesight of the volunteer monitor, it is best to have at least two people take readings. (Or, if the monitor is sampling alone, the monitor should take two readings.) In addition, please make sure that the readings are taken on the shady, non-windy side of the boat.
- **Sample Bottles:** The chlorophyll-a sample for the **July 29th** sampling event was not collected in the appropriate bottle. The sample was not rejected because the bottle was stored in a dark cooler. Specifically, the chlorophyll sample should be collected in the big brown light-proof bottle to limit the algae's ability to photosynthesize and produce more chlorophyll during the time period after sample collection and prior to analysis.

NOTES

- **Monitor's Note (7/29/02):** Lake level had been higher than normal since the beginning of the summer, due to above average rainfall during July. Also, there had been above average boat traffic during July. A sample was taken from a roadside seep (and tested for bacteria) because of evident orange slime with an oily film that had an unpleasant odor.
- **Biologist's Note (8/22/02):** There was some drifting during deep spot sampling. A sulfur smell from the hypolimnion sample was also observed.

USEFUL RESOURCES

Changes to the Comprehensive Shoreland Protection Act: 2001 Legislative Session, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/sp/sp-8.htm

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm

The Lake Pocket Book. Prepared by The Terrene Institute, 2000. (internet: www.terrene.org, phone 800-726-4853)

Managing Lakes and Reservoirs, Third Edition, 2001. Prepared by the North American Lake Management Society (NALMS) and the Terrene Institute in cooperation with the U.S. Environmental Protection Agency. Copies are available from NALMS (internet: www.nalms.org, phone 608-233-2836), and the Terrene Institute (internet: www.terrene.org, phone 800-726-4853)

Organizing Lake Users: A Practical Guide. Written by Gretchen Flock, Judith Taggart, and Harvey Olem. Copies are available from the Terrene Institute (internet: www.terrene.org, phone 800-726-4853)

Proper Lawn Care in the Protected Shoreland: The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm

Sand Dumping - Beach Construction, WD-BB-15, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm

Swimmers Itch, WD-BB-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-2.htm

Use of Lakes or Streams for Domestic Water Supply, WD-WSEB-1-11, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/ws/ws-1-11.htm

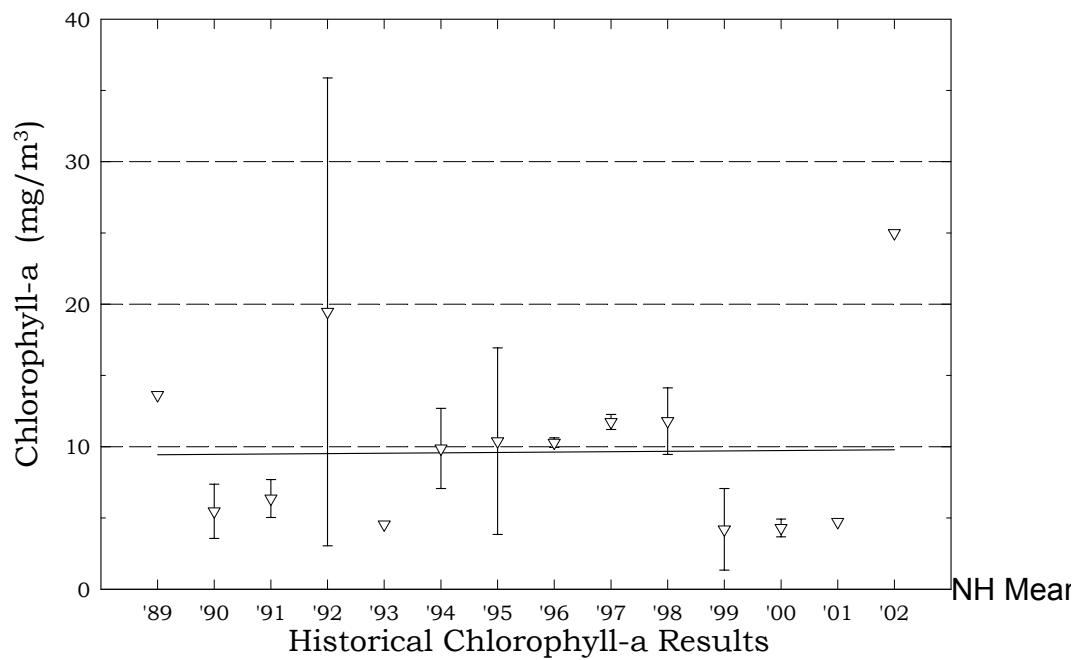
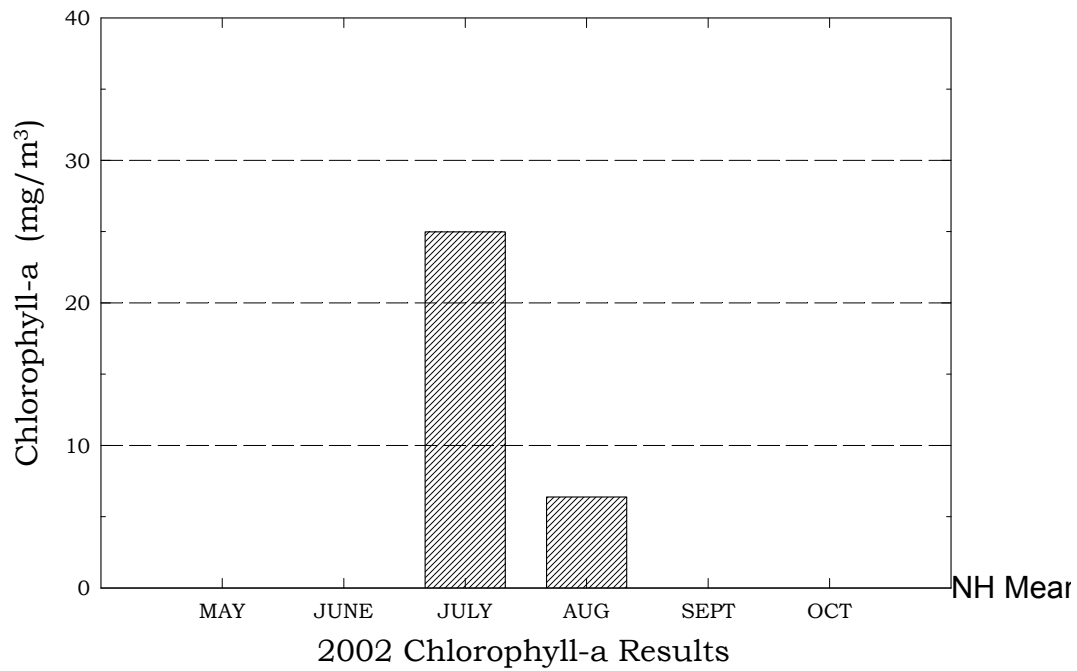
Water Milfoil, WD-BB-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-1.htm

Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-4.htm

Appendix A: Graphs

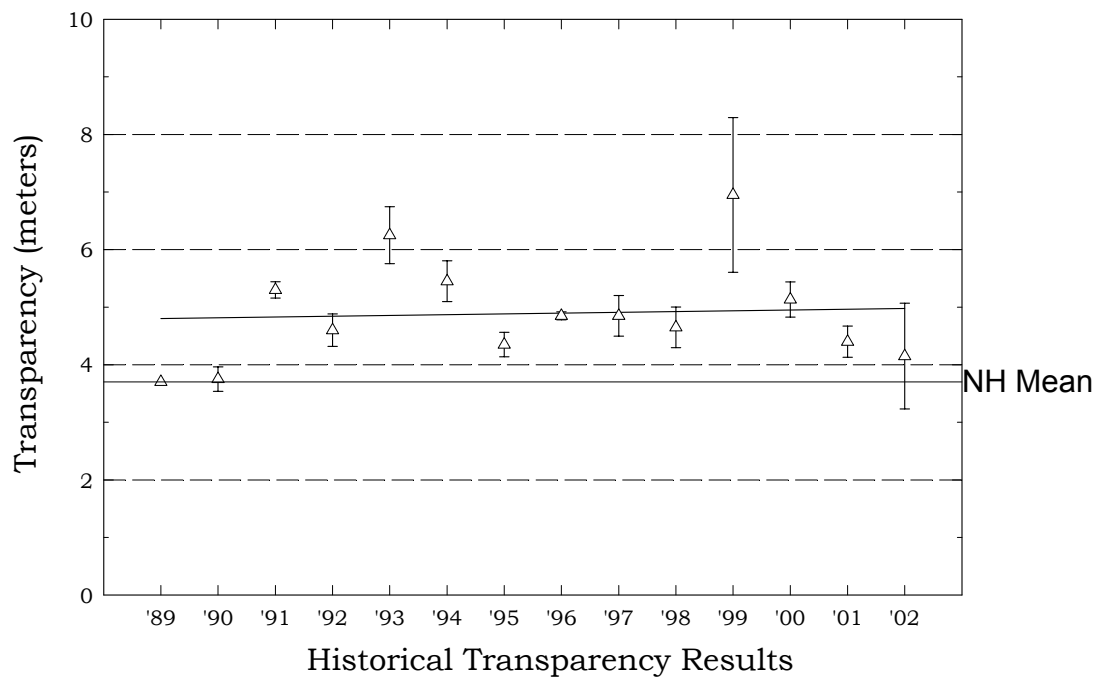
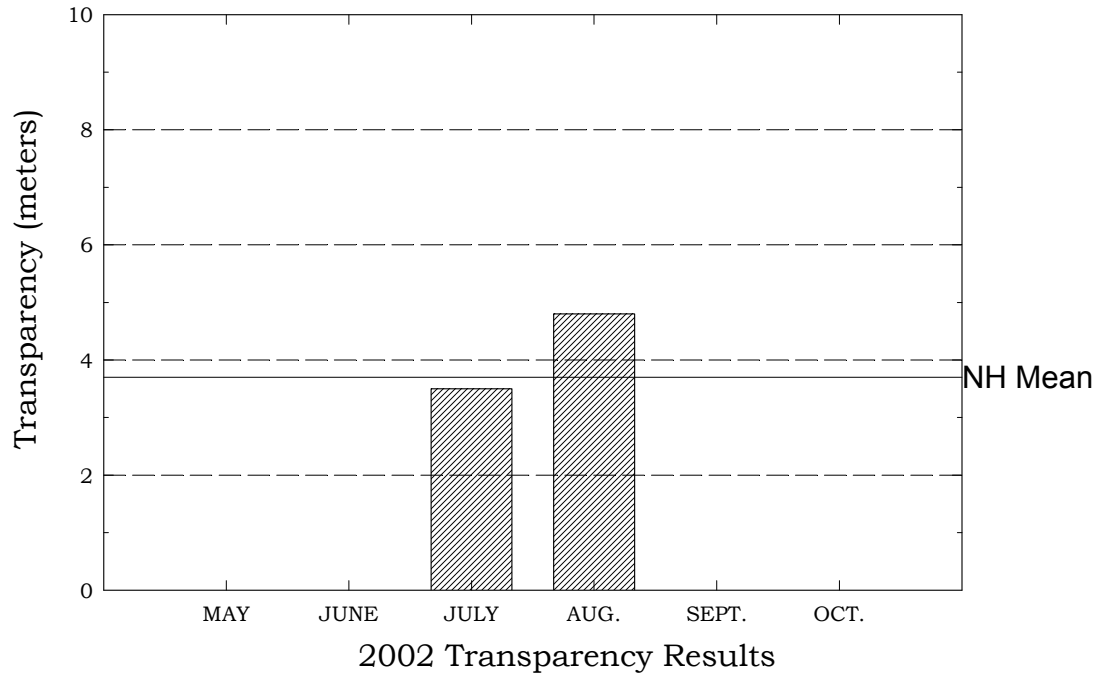
Partridge Lake, Littleton

Figure 1. Monthly and Historical Chlorophyll-a Results



Partridge Lake, Littleton

Figure 2. Monthly and Historical Transparency Results



Partridge Lake, Littleton

Figure 3. Monthly and Historical Total Phosphorus Data.

